

THE ASSISTANT COMMISSIONER OF PATENTS  
Washington, D.C. 20231

DOCKET NUMBER: 00-C-016  
September 7, 2000

Sir:

Transmitted herewith for filing is the Patent Application of:

Inventor(s): **Anthony M. Chiu**

For: **SURFACE MOUNT PACKAGE WITH INTEGRAL ELECTRO-STATIC CHARGE DISSIPATING RING USING LEAD FRAME AS ESD DEVICE**

Enclosed are:

- ☒ Patent Specification and Declaration
- ☒ 7 sheets of drawing(s).
- ☒ An assignment of the invention to STMicroelectronics, Inc. (includes Recordation Form Cover Sheet).
- ☐ A certified copy of a ☐ application.
- ☐ Information Disclosure Statement, PTO 1449 and copies of references.

The filing fee has been calculated as shown below:

For	Number Filed	Number Extra	Rate	Fee
Basic Fee				\$690.00
Total Claims	20 - 20	0	x 18 =	\$ .00
Indep. Claims	4 - 3	1	x 78 =	\$ 78.00
MULTIPLE DEPENDENT CLAIM PRESENTED			x 260 =	\$
			TOTAL	\$768.00

- ☒ Enclosed please find our checks in the amounts of \$768.00 and \$40.00.
- ☒ The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account 06-0580. A duplicate copy of this sheet is enclosed.
- ☒ Any additional filing fees required under 37 CFR §1.16.
- ☒ Any patent application processing fees under 37 CFR §1.17.

**CERTIFICATE OF EXPRESS MAILING UNDER 37 CFR § 1.10**

"Express Mail" Mailing Label Number: **EL139164334US**

Date of Mailing: September 7, 2000

I hereby certify that the documents indicated above are being deposited with the United States Postal Service under 37 CFR 1.10 on the date indicated above and are addressed to Box Patent Applications, Assistant Commissioner for Patents, Washington, D.C. 20231 and mailed on the above Date of Mailing with the above "Express Mail" mailing label number.

Beth Costner  
(name of person mailing paper)

Beth Costner  
SIGNATURE of person mailing paper or fee

Respectfully submitted,

By Dan Venglarik  
Dan Venglarik  
Registration No. 39,409 for  
FELSMAN, BRADLEY, VADEN  
GUNTER & DILLON, LLP  
201 Main Street, Suite 1600  
Fort Worth, Texas 76102  
Telephone (817) 332-8143

S P E C I F I C A T I O N

Docket No. 00-C-016

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN that I, Anthony M. Chiu, a citizen of the United States of America residing in the State of Texas, have invented new and useful improvements in a

**SURFACE MOUNT PACKAGE WITH INTEGRAL ELECTRO-STATIC CHARGE  
DISSIPATING RING USING LEAD FRAME AS ESD DEVICE**

of which the following is a specification:

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention:

5           The present invention relates generally to packaging  
integrated circuit devices and in particular to providing  
electrical discharge properties to integrated circuit device  
packaging. Still more particularly, the present invention  
relates to forming a metal ring an integrated circuit from a  
10       portion of a lead frame for the purpose of conducting electro-  
static energy away from the integrated circuit.

### 2. Description of the Prior Art:

15           In conventional integrated circuits, electrostatic  
discharge (ESD) events typically enter the circuitry through  
the pad ring, which dissipates the charge before reaching the  
core. Some recently developed integrated circuits, however,  
must necessarily expose the core of the circuitry to ESD  
20       events. Contemporary fingerprint sensors, for example, often  
include a two-dimensional array of sensing electrodes  
proximate to a sensing surface on which the finger is placed,  
with ridges and valleys on the finger skin detected by  
capacitance variations caused by the varying distance between  
25       the skin surface and the sensor electrodes. The need for  
contact with the finger in order to detect fingerprint  
features necessitates exposure of the integrated circuit to  
electrostatic discharge events resulting from a finger  
touching the sensing surface.

30           The electrostatic charge which may be carried by a human  
body oftens fall within the range of several kilovolts or  
more. Typical electrostatic discharge protection circuits

have proven somewhat ineffective in safely dissipating such charges, which may provide sufficient energy to break through upper dielectric/passivation layer.

5           Additionally, integrated circuits which cannot be  
completely encapsulated--except for conductive leads to the  
circuit--during packaging (e.g., fingerprint sensors, optical  
sensors, and other circuit requiring that a portion of the  
integrated circuit remain exposed) are typically mounted  
10 utilizing "Chip On Board" technology. The integrated circuits  
are mounted on a printed circuit board in an unencapsulated  
form, connected to the printed circuit board through the bond  
wires, then protected utilizing liquid encapsulation or  
silicon gel. Such mounting, which involves the use of gold  
plating of the substrate, is much more expensive than  
conventional surface mounting of integrated circuits on a  
stamped lead frame. However, viable surface mounting of  
fingerprint sensors on lead frames has not yet been achieved.

15  
20  
25  
30  
35  
40  
45  
50  
55  
60  
65  
70  
75  
80  
85  
90  
95  
100  
105  
110  
115  
120  
125  
130  
135  
140  
145  
150  
155  
160  
165  
170  
175  
180  
185  
190  
195  
200  
205  
210  
215  
220  
225  
230  
235  
240  
245  
250  
255  
260  
265  
270  
275  
280  
285  
290  
295  
300  
305  
310  
315  
320  
325  
330  
335  
340  
345  
350  
355  
360  
365  
370  
375  
380  
385  
390  
395  
400  
405  
410  
415  
420  
425  
430  
435  
440  
445  
450  
455  
460  
465  
470  
475  
480  
485  
490  
495  
500  
505  
510  
515  
520  
525  
530  
535  
540  
545  
550  
555  
560  
565  
570  
575  
580  
585  
590  
595  
600  
605  
610  
615  
620  
625  
630  
635  
640  
645  
650  
655  
660  
665  
670  
675  
680  
685  
690  
695  
700  
705  
710  
715  
720  
725  
730  
735  
740  
745  
750  
755  
760  
765  
770  
775  
780  
785  
790  
795  
800  
805  
810  
815  
820  
825  
830  
835  
840  
845  
850  
855  
860  
865  
870  
875  
880  
885  
890  
895  
900  
905  
910  
915  
920  
925  
930  
935  
940  
945  
950  
955  
960  
965  
970  
975  
980  
985  
990  
995  
1000  
1005  
1010  
1015  
1020  
1025  
1030  
1035  
1040  
1045  
1050  
1055  
1060  
1065  
1070  
1075  
1080  
1085  
1090  
1095  
1100  
1105  
1110  
1115  
1120  
1125  
1130  
1135  
1140  
1145  
1150  
1155  
1160  
1165  
1170  
1175  
1180  
1185  
1190  
1195  
1200  
1205  
1210  
1215  
1220  
1225  
1230  
1235  
1240  
1245  
1250  
1255  
1260  
1265  
1270  
1275  
1280  
1285  
1290  
1295  
1300  
1305  
1310  
1315  
1320  
1325  
1330  
1335  
1340  
1345  
1350  
1355  
1360  
1365  
1370  
1375  
1380  
1385  
1390  
1395  
1400  
1405  
1410  
1415  
1420  
1425  
1430  
1435  
1440  
1445  
1450  
1455  
1460  
1465  
1470  
1475  
1480  
1485  
1490  
1495  
1500  
1505  
1510  
1515  
1520  
1525  
1530  
1535  
1540  
1545  
1550  
1555  
1560  
1565  
1570  
1575  
1580  
1585  
1590  
1595  
1600  
1605  
1610  
1615  
1620  
1625  
1630  
1635  
1640  
1645  
1650  
1655  
1660  
1665  
1670  
1675  
1680  
1685  
1690  
1695  
1700  
1705  
1710  
1715  
1720  
1725  
1730  
1735  
1740  
1745  
1750  
1755  
1760  
1765  
1770  
1775  
1780  
1785  
1790  
1795  
1800  
1805  
1810  
1815  
1820  
1825  
1830  
1835  
1840  
1845  
1850  
1855  
1860  
1865  
1870  
1875  
1880  
1885  
1890  
1895  
1900  
1905  
1910  
1915  
1920  
1925  
1930  
1935  
1940  
1945  
1950  
1955  
1960  
1965  
1970  
1975  
1980  
1985  
1990  
1995  
2000  
2005  
2010  
2015  
2020  
2025  
2030  
2035  
2040  
2045  
2050  
2055  
2060  
2065  
2070  
2075  
2080  
2085  
2090  
2095  
2100  
2105  
2110  
2115  
2120  
2125  
2130  
2135  
2140  
2145  
2150  
2155  
2160  
2165  
2170  
2175  
2180  
2185  
2190  
2195  
2200  
2205  
2210  
2215  
2220  
2225  
2230  
2235  
2240  
2245  
2250  
2255  
2260  
2265  
2270  
2275  
2280  
2285  
2290  
2295  
2300  
2305  
2310  
2315  
2320  
2325  
2330  
2335  
2340  
2345  
2350  
2355  
2360  
2365  
2370  
2375  
2380  
2385  
2390  
2395  
2400  
2405  
2410  
2415  
2420  
2425  
2430  
2435  
2440  
2445  
2450  
2455  
2460  
2465  
2470  
2475  
2480  
2485  
2490  
2495  
2500  
2505  
2510  
2515  
2520  
2525  
2530  
2535  
2540  
2545  
2550  
2555  
2560  
2565  
2570  
2575  
2580  
2585  
2590  
2595  
2600  
2605  
2610  
2615  
2620  
2625  
2630  
2635  
2640  
2645  
2650  
2655  
2660  
2665  
2670  
2675  
2680  
2685  
2690  
2695  
2700  
2705  
2710  
2715  
2720  
2725  
2730  
2735  
2740  
2745  
2750  
2755  
2760  
2765  
2770  
2775  
2780  
2785  
2790  
2795  
2800  
2805  
2810  
2815  
2820  
2825  
2830  
2835  
2840  
2845  
2850  
2855  
2860  
2865  
2870  
2875  
2880  
2885  
2890  
2895  
2900  
2905  
2910  
2915  
2920  
2925  
2930  
2935  
2940  
2945  
2950  
2955  
2960  
2965  
2970  
2975  
2980  
2985  
2990  
2995  
3000  
3005  
3010  
3015  
3020  
3025  
3030  
3035  
3040  
3045  
3050  
3055  
3060  
3065  
3070  
3075  
3080  
3085  
3090  
3095  
3100  
3105  
3110  
3115  
3120  
3125  
3130  
3135  
3140  
3145  
3150  
3155  
3160  
3165  
3170  
3175  
3180  
3185  
3190  
3195  
3200  
3205  
3210  
3215  
3220  
3225  
3230  
3235  
3240  
3245  
3250  
3255  
3260  
3265  
3270  
3275  
3280  
3285  
3290  
3295  
3300  
3305  
3310  
3315  
3320  
3325  
3330  
3335  
3340  
3345  
3350  
3355  
3360  
3365  
3370  
3375  
3380  
3385  
3390  
3395  
3400  
3405  
3410  
3415  
3420  
3425  
3430  
3435  
3440  
3445  
3450  
3455  
3460  
3465  
3470  
3475  
3480  
3485  
3490  
3495  
3500  
3505  
3510  
3515  
3520  
3525  
3530  
3535  
3540  
3545  
3550  
3555  
3560  
3565  
3570  
3575  
3580  
3585  
3590  
3595  
3600  
3605  
3610  
3615  
3620  
3625  
3630  
3635  
3640  
3645  
3650  
3655  
3660  
3665  
3670  
3675  
3680  
3685  
3690  
3695  
3700  
3705  
3710  
3715  
3720  
3725  
3730  
3735  
3740  
3745  
3750  
3755  
3760  
3765  
3770  
3775  
3780  
3785  
3790  
3795  
3800  
3805  
3810  
3815  
3820  
3825  
3830  
3835  
3840  
3845  
3850  
3855  
3860  
3865  
3870  
3875  
3880  
3885  
3890  
3895  
3900  
3905  
3910  
3915  
3920  
3925  
3930  
3935  
3940  
3945  
3950  
3955  
3960  
3965  
3970  
3975  
3980  
3985  
3990  
3995  
4000  
4005  
4010  
4015  
4020  
4025  
4030  
4035  
4040  
4045  
4050  
4055  
4060  
4065  
4070  
4075  
4080  
4085  
4090  
4095  
4100  
4105  
4110  
4115  
4120  
4125  
4130  
4135  
4140  
4145  
4150  
4155  
4160  
4165  
4170  
4175  
4180  
4185  
4190  
4195  
4200  
4205  
4210  
4215  
4220  
4225  
4230  
4235  
4240  
4245  
4250  
4255  
4260  
4265  
4270  
4275  
4280  
4285  
4290  
4295  
4300  
4305  
4310  
4315  
4320  
4325  
4330  
4335  
4340  
4345  
4350  
4355  
4360  
4365  
4370  
4375  
4380  
4385  
4390  
4395  
4400  
4405  
4410  
4415  
4420  
4425  
4430  
4435  
4440  
4445  
4450  
4455  
4460  
4465  
4470  
4475  
4480  
4485  
4490  
4495  
4500  
4505  
4510  
4515  
4520  
4525  
4530  
4535  
4540  
4545  
4550  
4555  
4560  
4565  
4570  
4575  
4580  
4585  
4590  
4595  
4600  
4605  
4610  
4615  
4620  
4625  
4630  
4635  
4640  
4645  
4650  
4655  
4660  
4665  
4670  
4675  
4680  
4685  
4690  
4695  
4700  
4705  
4710  
4715  
4720  
4725  
4730  
4735  
4740  
4745  
4750  
4755  
4760  
4765  
4770  
4775  
4780  
4785  
4790  
4795  
4800  
4805  
4810  
4815  
4820  
4825  
4830  
4835  
4840  
4845  
4850  
4855  
4860  
4865  
4870  
4875  
4880  
4885  
4890  
4895  
4900  
4905  
4910  
4915  
4920  
4925  
4930  
4935  
4940  
4945  
4950  
4955  
4960  
4965  
4970  
4975  
4980  
4985  
4990  
4995  
5000  
5005  
5010  
5015  
5020  
5025  
5030  
5035  
5040  
5045  
5050  
5055  
5060  
5065  
5070  
5075  
5080  
5085  
5090  
5095  
5100  
5105  
5110  
5115  
5120  
5125  
5130  
5135  
5140  
5145  
5150  
5155  
5160  
5165  
5170  
5175  
5180  
5185  
5190  
5195  
5200  
5205  
5210  
5215  
5220  
5225  
5230  
5235  
5240  
5245  
5250  
5255  
5260  
5265  
5270  
5275  
5280  
5285  
5290  
5295  
5300  
5305  
5310  
5315  
5320  
5325  
5330  
5335  
5340  
5345  
5350  
5355  
5360  
5365  
5370  
5375  
5380  
5385  
5390  
5395  
5400  
5405  
5410  
5415  
5420  
5425  
5430  
5435  
5440  
5445  
5450  
5455  
5460  
5465  
5470  
5475  
5480  
5485  
5490  
5495  
5500  
5505  
5510  
5515  
5520  
5525  
5530  
5535  
5540  
5545  
5550  
5555  
5560  
5565  
5570  
5575  
5580  
5585  
5590  
5595  
5600  
5605  
5610  
5615  
5620  
5625  
5630  
5635  
5640  
5645  
5650  
5655  
5660  
5665  
5670  
5675  
5680  
5685  
5690  
5695  
5700  
5705  
5710  
5715  
5720  
5725  
5730  
5735  
5740  
5745  
5750  
5755  
5760  
5765  
5770  
5775  
5780  
5785  
5790  
5795  
5800  
5805  
5810  
5815  
5820  
5825  
5830  
5835  
5840  
5845  
5850  
5855  
5860  
5865  
5870  
5875  
5880  
5885  
5890  
5895  
5900  
5905  
5910  
5915  
5920  
5925  
5930  
5935  
5940  
5945  
5950  
5955  
5960  
5965  
5970  
5975  
5980  
5985  
5990  
5995  
6000  
6005  
6010  
6015  
6020  
6025  
6030  
6035  
6040  
6045  
6050  
6055  
6060  
6065  
6070  
6075  
6080  
6085  
6090  
6095  
6100  
6105  
6110  
6115  
6120  
6125  
6130  
6135  
6140  
6145  
6150  
6155  
6160  
6165  
6170  
6175  
6180  
6185  
6190  
6195  
6200  
6205  
6210  
6215  
6220  
6225  
6230  
6235  
6240  
6245  
6250  
6255  
6260  
6265  
6270  
6275  
6280  
6285  
6290  
6295  
6300  
6305  
6310  
6315  
6320  
6325  
6330  
6335  
6340  
6345  
6350  
6355  
6360  
6365  
6370  
6375  
6380  
6385  
6390  
6395  
6400  
6405  
6410  
6415  
6420  
6425  
6430  
6435  
6440  
6445  
6450  
6455  
6460  
6465  
6470  
6475  
6480  
6485  
6490  
6495  
6500  
6505  
6510  
6515  
6520  
6525  
6530  
6535  
6540  
6545  
6550  
6555  
6560  
6565  
6570  
6575  
6580  
6585  
6590  
6595  
6600  
6605  
6610  
6615  
6620  
6625  
6630  
6635  
6640  
6645  
6650  
6655  
6660  
6665  
6670  
6675  
6680  
6685  
6690  
6695  
6700  
6705  
6710  
6715  
6720  
6725  
6730  
6735  
6740  
6745  
6750  
6755  
6760  
6765  
6770  
6775  
6780  
6785  
6790  
6795  
6800  
6805  
6810  
6815  
6820  
6825  
6830  
6835  
6840  
6845  
6850  
6855  
6860  
6865  
6870  
6875  
6880  
6885  
6890  
6895  
6900  
6905  
6910  
6915  
6920  
6925  
6930  
6935  
6940  
6945  
6950  
6955  
6960  
6965  
6970  
6975  
6980  
6985  
6990  
6995  
7000  
7005  
7010  
7015  
7020  
7025  
7030  
7035  
7040  
7045  
7050  
7055  
7060  
7065  
7070  
7075  
7080  
7085  
7090  
7095  
7100  
7105  
7110  
7115  
7120  
7125  
7130  
7135  
7140  
7145  
7150  
7155  
7160  
7165  
7170  
7175  
7180  
7185  
7190  
7195  
7200  
7205  
7210  
7215  
7220  
7225  
7230  
7235  
7240  
7245  
7250  
7255  
7260  
7265  
7270  
7275  
7280  
7285  
7290  
7295  
7300  
7305  
7310  
7315  
7320  
7325  
7330  
7335  
7340  
7345  
7350  
7355  
7360  
7365  
7370  
7375  
7380  
7385  
7390  
7395  
7400  
7405  
7410  
7415  
7420  
7425  
7430  
7435  
7440  
7445  
7450  
7455  
7460  
7465  
7470  
7475  
7480  
7485  
7490  
7495  
7500  
7505  
7510  
7515  
7520  
7525  
7530  
7535  
7540  
7545  
7550  
7555  
7560  
7565  
7570  
7575  
7580  
7585  
7590  
7595  
7600  
7605  
7610  
7615  
7620  
7625  
7630  
7635  
7640  
7645  
7650  
7655  
7660  
7665  
7670  
7675  
7680  
7685  
7690  
7695  
7700  
7705  
7710  
7715  
7720  
7725  
7730  
7735  
7740  
7745  
7750  
7755  
7760  
7765  
7770  
7775  
7780  
7785  
7790  
7795  
7800  
7805  
7810  
7815  
7820  
7825  
7830  
7835  
7840  
7845  
7850  
7855  
7860  
7865  
7870  
7875  
7880  
7885  
7890  
7895  
7900  
7905  
7910  
7915  
7920  
7925  
7930  
7935  
7940  
7945  
7950  
7955  
7960  
7965  
7970  
7975  
7980  
7985  
7990  
7995  
8000  
8005  
8010  
8015  
8020  
8025  
8030  
8035  
8040  
8045  
8050  
8055  
8060  
8065  
8070  
8075  
8080  
8085  
8090  
8095  
8100  
8105  
8110  
8115  
8120  
8125  
8130  
8135  
8140  
8145  
8150  
8155  
8160  
8165  
8170  
8175  
8180  
8185  
8190  
8195  
8200  
8205  
8210  
8215  
8220  
8225  
8230  
8235  
8240  
8245  
8250  
8255  
8260  
8265  
8270  
8275  
8280  
8285  
8290  
8295  
8300  
8305  
8310  
8315  
8320  
8325  
8330  
8335  
8340  
8345  
8350  
8355  
8360  
8365  
8370  
8375  
8380  
8385  
8390  
8395  
8400  
8405  
8410  
8415  
8420  
8425  
8430  
8435  
8440  
8445  
8450  
8455  
8460  
8465  
8470  
8475  
8480  
8485  
8490  
8495  
8500  
8505  
8510  
8515  
8520  
8525  
8530  
8535  
8540  
8545  
8550  
8555  
8560  
8565  
8570  
8575  
8580  
8585  
8590  
8595  
8600  
8605  
8610  
8615  
8620  
8625  
8630  
8635  
8640  
8645  
8650  
8655  
8660  
8665  
8670  
8675  
8680  
8685  
8690  
8695  
8700  
8705  
8710  
8715  
8720  
8725  
8730  
8735  
8740  
8745  
8750  
8755  
8760  
8765  
8770  
8775  
8780  
8785  
8790  
8795  
8800  
8805  
8810  
8815  
8820  
8825  
8830  
8835  
8840  
8845  
8850  
8855  
8860  
8865  
8870  
8875  
8880  
8885  
8890  
8895  
8900  
8905  
8910  
8915  
8920  
8925  
8930  
8935  
8940  
8945  
8950  
8955  
8960  
8965  
8970  
8975  
8980  
8985  
8990  
8995  
9000  
9005  
9010  
9015  
9020  
9025  
9030  
9035  
9040  
9045  
9050  
9055  
9060  
9065  
9070  
9075  
9080  
9085  
9090  
9095  
9100  
9105  
9110  
9115  
9120  
9125  
9130  
9135  
9140  
9145  
9150  
9155  
9160  
9165  
9170  
9175  
9180  
9185  
9190  
9195  
9200  
9205  
9210  
9215  
9220  
9225  
9230  
9235  
9240  
9245  
9250  
9255  
9260  
9265  
9270  
9275  
9280  
9285  
9290  
9295  
9300  
9305  
9310  
9315  
9320  
9325  
9330  
9335  
9340  
9345  
9350  
9355  
9360  
9365  
9370  
9375  
9380  
9385  
9390  
9395  
9400  
9405  
9410  
9415  
9420  
9425  
9430  
9435  
9440  
9445  
9450  
9455  
9460  
9465  
9470  
9475  
9480  
9485  
9490  
9495  
9500  
9505  
9510  
9515  
9520  
9525  
9530  
9535  
9540  
9545  
9550  
9555  
9560  
9565  
9570  
9575  
9580  
9585  
9590  
9595  
9600  
9605  
9610  
9615  
9620  
9625  
9630  
9635  
9640  
9645  
9650  
9655  
9660  
9665  
9670  
9675  
9680  
9685  
9690  
9695  
9700  
9705  
9710  
9715  
9720  
9725  
9730  
9735  
9740  
9745  
9750  
9755  
9760  
9765  
9770  
9775  
9780  
9785  
9790  
9795  
9800  
9805  
9810  
9815  
9820  
9825  
9830  
9835  
9840  
9845  
9850  
9855  
9860  
9865  
9870  
9875  
9880  
9885  
9890  
9895  
9900  
9905  
9910  
9915  
9920  
9925  
9930  
9935  
9940  
9945  
9950  
9955  
9960  
9965  
9970  
9975  
9980  
9985  
9990  
9995  
10000  
10005  
10010  
10015  
10020  
10025  
10030  
10035  
10040  
10045  
10050  
10055  
10060  
10065  
10070  
10075  
10080  
10085  
10090  
10095  
10100  
10105  
10110  
10115  
10120  
10125  
10130  
10135  
10140  
10145  
10150  
10155  
10160  
10165  
10170  
10175  
10180  
10185  
10190  
10195  
10200  
10205  
10210  
10215  
10220

## SUMMARY OF THE INVENTION

5 In a packaged integrated circuit, electrostatic discharge protection is provided by portions of a lead frame on which the integrated circuit is mounted. The lead frame includes a die paddle on which an integrated circuit die is mounted, with plastic or epoxy material encapsulating exposed surfaces of the integrated circuit die except for a sensing surface, and supporting pins or leads formed from the lead frame. Portions 10 of the lead frame extending from the die paddle are folded around sides of the encapsulated integrated circuit die and over, or adjacent to and level with, a peripheral upper surface of the encapsulated integrated circuit die to form an electrostatic discharge ring. The lead frame portions folded around the integrated circuit package are connected to ground through a ground pin, so that charge on a human finger touching the electrostatic discharge ring is dissipated to ground before the finger contacts a sensing surface of the integrated circuit. The portions of the lead frame which are folded around the encapsulated integrated circuit die may extend only around sides or side regions of the integrated circuit package not including pins or leads or, alternatively, may extend around all sides of the integrated circuit package and have openings where side regions of the integrated circuit package includes pins or leads. 25

## BRIEF DESCRIPTION OF THE DRAWINGS

5 The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, and further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

10 **Figures 1A-1E** depict various views of a packaged surface mount integrated circuit having an integral electrostatic discharge ring formed from lead frame portions in accordance with a preferred embodiment of the present invention;

15 **Figures 2A-2D** are various views of alternative designs for a packaged surface mount integrated circuit having an integral electrostatic discharge ring formed from lead frame portions in accordance with a preferred embodiment of the present invention;

20 **Figures 3A-3B** depict plan views of lead frame strips utilized in forming a packaged surface mount integrated circuit having an integral electrostatic discharge ring formed from lead frame portions in accordance with a preferred embodiment of the present invention; and

25 **Figures 4A-4C** are various views of a narrow-strip packaged integrated circuit with gull-wing leads and an integral electrostatic discharge ring formed from lead frame portions in accordance with a preferred embodiment of the present invention.

## DETAILED DESCRIPTION

5 The following description details the structure, application and features of the present invention, but it will be understood by those of skill in the art that the scope of the invention is defined only by the issued claims, and not by any description herein. The process steps and structures described below do not form a complete process flow for manufacturing integrated circuit packages. The present invention can be practiced in conjunction with integrated circuit package fabrication techniques currently used in the art, and only so much of the commonly practiced process steps are included as are necessary for an understanding of the present invention. The figures showing portions of an integrated circuit package during fabrication are not necessarily drawn to scale, but instead are drawn so as to illustrate the important features of the invention.

10 With reference now to the figures, and in particular with reference to **Figures 1A** through **1E**, various views of a packaged surface mount integrated circuit having an integral electrostatic discharge ring formed from a lead frame portion in accordance with a preferred embodiment of the present invention are depicted. **Figure 1A** depicts a plan view of the integrated circuit package **102**, while **Figure 1B** depicts a side view, **Figure 1C** depicts a cross-sectional view taken at section lines **A-A**, **Figure 1D** depicts a back or bottom view, and **Figure 1E** depicts an isometric view. Packaged integrated circuit **102** in the exemplary embodiment includes an fingerprint sensor integrated circuit die **104** having a sensing surface **106** proximate to an array of sensor electrodes. A finger is placed on sensing surface **106** of packaged integrated

circuit 102 in order to detect the fingerprint; accordingly, sensing surface 106 must remain exposed and should not be encapsulated.

5 Integrated circuit die 104 is mounted on a stamped metal lead frame 108, affixed to lead frame 108 by an adhesive 110. A peripheral portion of the integrated circuit die 104, not including sensing surface 106, is encapsulated in a plastic or epoxy material 112 protecting the integrated circuit and wire  
10 bonds 114 connecting the integrated circuit die 104 to pins 116 formed from a portion of the lead frame 108. Plastic or epoxy material 112 is formed by molding in accordance with the known art. A lead frame strip having several lead frames, each bearing an integrated circuit die and wire bonds connecting the integrated circuit die to the respective lead frame, is mounted on the mold with the integrated circuit die and wire bonds received by a mold cavity. The mold cavity includes surfaces contacting the sensing surface 106 of each integrated circuit die to prevent plastic or epoxy encapsulating material from adhering to the sensing surface. Plastic or epoxy material is then formed to encapsulate portions of the integrated circuit die not contacted by the mold surface, the wire bonds, and the surfaces of the lead frame overlying the mold cavity.

25 Also formed from a portion of lead frame 108 is an electrostatic discharge ring. The electrostatic discharge ring is formed by folding a portion of the lead frame 108 from the bottom of integrated circuit die 104 and plastic or epoxy  
30 material 112 up around the sides and over a peripheral portion of the top surface. Lead frame 108 is stamped with portions



preformed for folding over the sides and top during lead frame trim and form operations.

After packaging is completed, lead frame 108 includes a first portion 108a underlying the integrated circuit die 104, plastic or epoxy material 112, and bond wires 114. Much of first portion 108a comprises a die paddle to which the integrated circuit die is affixed. Second portions 108b along the sides of the integrated circuit package 102, and third portions 108c overlying a peripheral portion of an upper surface of integrated circuit package 102. (Part of the overlying peripheral portion 108c is depicted as broken-away on the left side of **Figure 1A** to depict pins 114). Pins 116 are also formed from portions of the stamped lead frame 108, but are, for the most part, separated from lead frame 108 during packaging trim and form operations and are held in place by plastic or epoxy material 112. At least one pin 116a (best seen in **Figure 1D**) remains connected to lead frame 108, serving as a ground connection for the electrostatic discharge ring. The remaining pins are, after fabrication of integrated circuit package 102 is complete, electrically and physically isolated from lead frame 108 and pin 116a, and may instead be electrically connected to the integrated circuit die 104 via bond wires 114.

As illustrated in **Figure 1E**, the electrostatic discharge ring formed by the folded portions of lead frame 108b and 108c may extend along a peripheral edge 118a of packaged integrated circuit 102 which is opposite pins 116, with an opening

through the folded lead frame portions **108b** and **108c** allowing access to pins **116** for an external connector. Alternatively, the electrostatic discharge ring may contain a broken region along a peripheral edge **118b** opposite pins **116**. The required length of the pins which must remain exposed for a connector, the thickness of the integrated circuit **104** and plastic or epoxy material **112**, and other design considerations may affect whether the electrostatic discharge ring extends along a complete circumference of the packaged integrated circuit **102**.

Referring to **Figures 2A** through **2D**, various views of alternative designs for a packaged surface mount integrated circuit having an integral electrostatic discharge ring formed from lead frame portions in accordance with a preferred embodiment of the present invention are illustrated. While the embodiment of **Figure 1A** through **1E** included straight pins for connection of the packaged integrated circuit to an external connector receiving the pins, the embodiments of **Figures 2A** through **2D** include gull wing leads for mounting the packaged integrated circuit on a printed circuit board with soldered connections.

**Figure 2A** is a plan view of one alternative embodiment of a packaged surface mount integrated circuit having an integral electrostatic discharge ring formed from lead frame portions, while **Figure 2B** is a cross-sectional view of the same alternative embodiment taken at section lines **B-B**. Packaged integrated circuit **202a** includes an integrated circuit die **204** containing sensor circuitry and including a sensor surface **206**. Integrated circuit die **204** is affixed on a bottom surface to lead frame **208** by an adhesive **210**, and is partially

encapsulated on remaining surfaces by a plastic or epoxy material 212, but not over sensing surface 206. Plastic or epoxy material 212 also encapsulates bond wires 214 electrically connecting the integrated circuit die 204 to the leads 216.

While the embodiment of **Figures 1A** through **1E** included (or could have included) an electrostatic discharge ring along an entire circumference of an upper peripheral edge of the packaged integrated circuit, the length of lead frame material required to form gull wing leads 216 and the thin dimension of the packaged integrated circuit in the embodiment of **Figures 2A** through **2D** prevents the electrostatic discharge ring from extending all the way around the packaged integrated circuit 202a. Nonetheless, portions 208b and 208c of the lead frame 208 are folded up around the sides and over a peripheral top portion of packaged integrated circuit 202a wherever possible to form an incomplete "ring" connected to ground and dissipating electrostatic charge when contacted by a human finger.

**Figure 2C** is a plan view of another alternative embodiment of a packaged surface mount integrated circuit having an integral electrostatic discharge ring formed from lead frame portions, while **Figure 2D** is a cross-sectional view of that alternative embodiment taken at section lines C-C. While the embodiment shown in **Figures 2A** and **2B** includes wire bonds 214 within plastic or epoxy material 212 on only one side, the packaged integrated circuit 202b of **Figures 2C** and **2D** includes bond wires 214 encapsulated by plastic or epoxy

material 212 on both sides. Either structure may be formed in the present invention.

With reference now to **Figures 3A** and **3B**, plan views of lead frame strips utilized in forming a packaged surface mount integrated circuit having an integral electrostatic discharge ring formed from lead frame portions in accordance with a preferred embodiment of the present invention are depicted. The uncut lead frame strip 300 depicted in both **Figure 3A** and **3B** contains a plurality of lead frames with integral electrostatic discharge ring portions for packaging integrated circuits. Each lead frame includes a die paddle 302 to which the integrated circuit die is affixed. Sections 304 of the lead frame will form the electrostatic discharge ring after being folded up around the sides and over an upper peripheral portion of the integrated circuit structure being packaged by the lead frame.

Other portions 306 of the lead frame will form the pins or leads of the finished integrated circuit package and will be separated from the remainder of the lead frame during trim and form operations, except for one or more pins or leads providing a grounding connection to the lead frame and electrostatic discharge ring. The pins or leads formed from portions 306 will be held in place by plastic or epoxy encapsulating material molded around at least parts of the integrated circuit die mounted on the leadframe, and will be electrically connected to the integrated circuit by bond wires within the plastic or epoxy encapsulating material. Shorting bars 308, containing "tooling" or alignment holes 310, provide structural support for the lead frame and will be removed during lead frame trim and form operations.

During lead frame trim and form operations, sections of each lead frames will be folded along the dashed fold lines 312 depicted in **Figure 3B**. These sections will be folded up around the sides and over a peripheral upper surface of the integrated circuit package to form the electrostatic discharge ring. These sections remain physically and electrically connected to the lead frame die paddle on which the integrated circuit die is mounted, and are connected through the lead frame to a grounding connection. When a human finger touches the electrostatic discharge ring formed from these folded section in contacting the sensing surface of the packaged integrated circuit, any electrostatic charge is dissipated to ground by the electrostatic discharge ring.

Referring to **Figures 4A-4C**, various views of a narrow-strip packaged integrated circuit with gull-wing leads and an integral electrostatic discharge ring formed from lead frame portions in accordance with a preferred embodiment of the present invention are illustrated. **Figure 4A** shows a plan view of narrow-strip packaged integrated circuit 402, while **Figure 4B** shows a side view and **Figure 4C** shows a cross-sectional view taken at section lines D-D. Packaged integrated circuit 402 includes an integrated circuit die 404 having a sensing surface 406 mounted on a lead frame 408 with an adhesive 410. Plastic or epoxy material 412 encapsulates portions of integrated circuit die 404 other than sensing surface 406 and wire bonds 414 connecting integrated circuit die 404 to leads 416. Leads 416 are formed from portions of lead frame 408, but are separated from lead frame 408 during lead frame trim and form operations, except for one lead

providing a grounding connection for lead frame 408 and the electrostatic discharge ring.

5 Portions 408b and 408c of the lead frame 408 projecting from a bottom portion 408a are folded up around the sides of the package (portions 408c) and bent over to be level with an upper surface of plastic or epoxy material 412. These portions 408b and 408c form an electrostatic discharge "ring" for packaged integrated circuit 402 by providing a low resistance path to ground. Because of the narrowness of the package and the required length of leads 416, the electrostatic discharge "ring" is formed only along the long edges of package 402, and not on the ends. However, the portions 408b and 408c of lead frame 408 which form the electrostatic discharge protection are close enough to the exposed sensing surface of the packaged integrated circuit to be contacted when a finger touches the sensing surface.

10 In the present invention, an electrostatic discharge ring for packaged integrated circuits is integrally formed from a portion functions by creating a path for accumulated electric charge to flow from the human finger or other item touching the packaged device to ground. Because the electrostatic discharge ring presents a low resistance path relative to the sensor area and the packaging materials, the electrostatic discharge ring serves as the preferred path from a region of high charge to a grounded region. Therefore, when a user of the sensor touches the sensor area, the user's finger will contact or come in close proximity with the electrostatic discharge ring, at which time any excess charge accumulated on the user will pass through the electrostatic discharge ring to ground, protecting the integrated circuit within the package.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

004055-030700

What is claimed is:

1        1.    A method of providing electrostatic discharge protection  
2        for an integrated circuit, comprising:  
3                mounting an integrated circuit die on a lead frame;  
4                encapsulating at least part of the integrated circuit die  
5        with a plastic or epoxy material; and  
6                folding a portion of the lead frame around sides of the  
7        encapsulated integrated circuit die and over or adjacent to a  
8        peripheral upper surface of the plastic or epoxy material.

1        2.    The method of claim 1, further comprising:  
2                connecting the portion of the lead frame folded around  
3        the sides of the encapsulated integrated circuit die and over  
4        or adjacent to the peripheral upper surface of the plastic or  
5        epoxy material to a ground voltage.

1        3.    The method of claim 1, wherein the step of encapsulating  
2        at least part of the integrated circuit die with a plastic or  
3        epoxy material further comprising:  
4                after mounting the integrated circuit die on the lead  
5        frame, encapsulating exposed surfaces of the integrated  
6        circuit die except for a sensing surface; and  
7                encapsulating wire bonds connecting the integrated  
8        circuit die to portions of the lead frame.

1        4.    The method of claim 1, wherein the step of folding a  
2        portion of the lead frame around sides of the encapsulated  
3        integrated circuit die and over or adjacent to a peripheral  
4        upper surface of the plastic or epoxy material further  
5        comprising:  
6                folding portions of the lead frame around each side of  
7        the encapsulated integrated circuit die.



1 5. The method of claim 1, wherein the step of folding a  
2 portion of the lead frame around sides of the encapsulated  
3 integrated circuit die and over or adjacent to a peripheral  
4 upper surface of the plastic or epoxy material further  
5 comprising:

6 folding a first portion of the lead frame around a first  
7 side of the encapsulated integrated circuit die, wherein the  
8 first portion includes an opening providing access for a  
9 connector to pins electrically connected to the integrated  
10 circuit die.

1 6. The method of claim 1, wherein the step of folding a  
2 portion of the lead frame around sides of the encapsulated  
3 integrated circuit die and over or adjacent to a peripheral  
4 upper surface of the plastic or epoxy material further  
5 comprising:

6 folding portions of the lead frame around edges of the  
7 encapsulated integrated circuit die not including leads  
8 electrically connected to the integrated circuit die.

1 7. The method of claim 1, wherein the step of folding a  
2 portion of the lead frame around sides of the encapsulated  
3 integrated circuit die and over or adjacent to a peripheral  
4 upper surface of the plastic or epoxy material further  
5 comprising:

6 folding a first portion of the lead frame around a side  
7 of the encapsulated integrated circuit die; and

8 folding a second portion of the lead frame extending from  
9 the first portion over a peripheral upper surface of the  
10 encapsulated integrated circuit die.

1 8. The method of claim 1, wherein the step of folding a  
2 portion of the lead frame around sides of the encapsulated  
3 integrated circuit die and over or adjacent to a peripheral

4 upper surface of the plastic or epoxy material further  
5 comprising:

6 folding a first portion of the lead frame around a side  
7 of the encapsulated integrated circuit die; and

8 folding a second portion of the lead frame extending from  
9 the first portion adjacent to and level with a peripheral  
10 upper surface of the encapsulated integrated circuit die.

00/0000-48593360

1 9. An integrated circuit package, comprising:  
2 an integrated circuit die mounted on a lead frame; and  
3 a plastic or epoxy material encapsulating at least part  
4 of the integrated circuit die,  
5 wherein a portion of the lead frame is folded around  
6 sides of the encapsulated integrated circuit die and over or  
7 adjacent to a peripheral upper surface of the plastic or epoxy  
8 material.

1 10. The integrated circuit package of claim 9, further  
2 comprising:

3 a connection between a ground voltage and the portion of  
4 the lead frame folded around the sides of the encapsulated  
5 integrated circuit die and over or adjacent to the peripheral  
6 upper surface of the plastic or epoxy material.

1 11. The integrated circuit package of claim 9, wherein the  
2 plastic or epoxy material encapsulates exposed surfaces of the  
3 integrated circuit die except for a sensing surface and wire  
4 bonds connecting the integrated circuit die to portions of the  
5 lead frame.

1 12. The integrated circuit package of claim 9, wherein  
2 portions of the lead frame are folded around each side of the  
3 encapsulated integrated circuit die.

1 13. The integrated circuit package of claim 9, wherein a  
2 first portion of the lead frame folded around a first side of  
3 the encapsulated integrated circuit die includes an opening  
4 providing access for a connector to pins electrically  
5 connected to the integrated circuit die.

1 14. The integrated circuit package of claim 9, wherein  
2 portions of the lead frame are folded only around edges of the

3 encapsulated integrated circuit die not including leads  
4 electrically connected to the integrated circuit die.

1 15. The integrated circuit package of claim 9, wherein:  
2 a first portion of the lead frame is folded around a side  
3 of the encapsulated integrated circuit die; and  
4 a second portion of the lead frame extending from the  
5 first portion is folded over a peripheral upper surface of the  
6 encapsulated integrated circuit die.

1 16. The integrated circuit package of claim 9, wherein:  
2 a first portion of the lead frame is folded around a side  
3 of the encapsulated integrated circuit die; and  
4 a second portion of the lead frame extending from the  
5 first portion is folded adjacent to and level with a  
6 peripheral upper surface of the encapsulated integrated  
circuit die.

1 17. An integrated circuit package, comprising:  
2 a lead frame including a die paddle and portions  
3 extending from the die paddle;  
4 an integrated circuit die mounted on the die paddle;  
5 a plastic or epoxy material encapsulating exposed  
6 surfaces of the integrated circuit die except for a sensing  
7 surface,  
8 wherein the portions of the lead frame extending from the  
9 die paddle are folded around sides of the encapsulated  
10 integrated circuit die and over or adjacent to peripheral  
11 upper surfaces of the encapsulated integrated circuit die.

1 18. The integrated circuit package of claim 17, wherein the  
2 lead frame includes pins or leads and the portions extending  
3 from the die paddle include openings around the pins or leads.

1 19. The integrated circuit package of claim 17, wherein the  
2 lead frame includes pins or leads and the portions extending  
3 from the die paddle project from peripheral edges of the die  
4 paddle not adjacent to the pins or leads.

1 20. A lead frame strip for an integrated circuit package,  
2 comprising:

3 at least one lead frame, the lead frame including:

4 a die paddle on which an integrated circuit will be  
5 mounted;

6 a plurality of structures which will be formed into  
7 pins or leads for the integrated circuit package; and

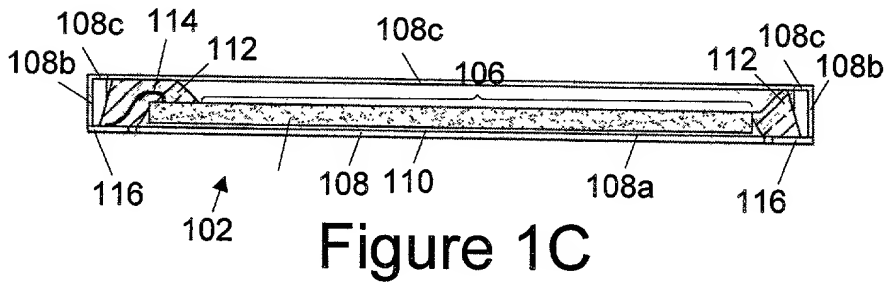
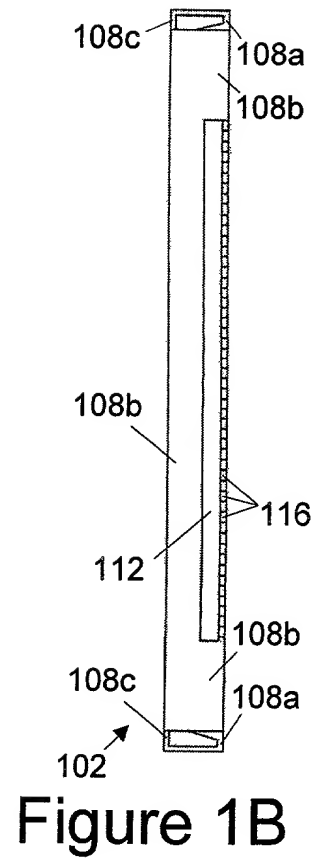
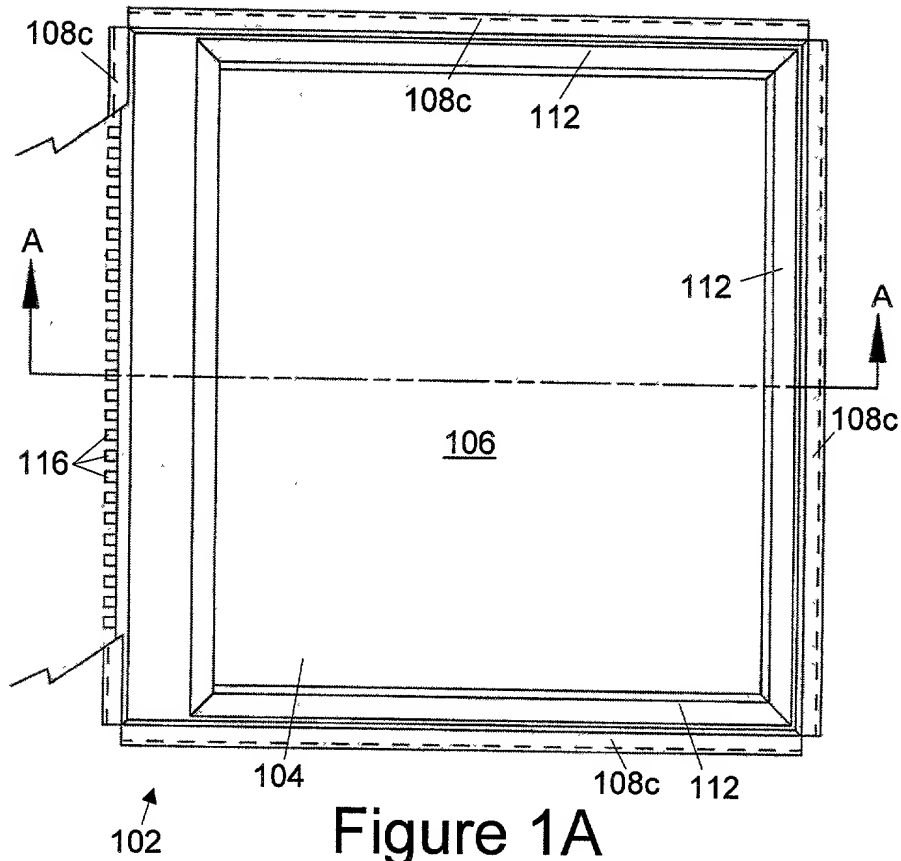
8 portions extending from the die paddle which will be  
9 folded around sides of the integrated circuit package and  
10 over or adjacent to a peripheral upper surface of the  
11 integrated circuit package to form an electrostatic  
12 discharge ring.

004055-43895560

**SURFACE MOUNT PACKAGE WITH INTEGRAL ELECTRO-STATIC CHARGE**  
**DISSIPATING RING USING LEAD FRAME AS ESD DEVICE**

**ABSTRACT OF THE DISCLOSURE**

5  
10  
15  
20  
25  
In a packaged integrated circuit, electrostatic discharge protection is provided by portions of a lead frame on which the integrated circuit is mounted. The lead frame includes a die paddle on which an integrated circuit die is mounted, with plastic or epoxy material encapsulating exposed surfaces of the integrated circuit die except for a sensing surface, and supporting pins or leads formed from the lead frame. Portions of the lead frame extending from the die paddle are folded around sides of the encapsulated integrated circuit die and over, or adjacent to and level with, a peripheral upper surface of the encapsulated integrated circuit die to form an electrostatic discharge ring. The lead frame portions folded around the integrated circuit package are connected to ground through a ground pin, so that charge on a human finger touching the electrostatic discharge ring is dissipated to ground before the finger contacts a sensing surface of the integrated circuit. The portions of the lead frame which are folded around the encapsulated integrated circuit die may extend only around sides or side regions of the integrated circuit package not including pins or leads or, alternatively, may extend around all sides of the integrated circuit package and have openings where side regions of the integrated circuit package includes pins or leads.





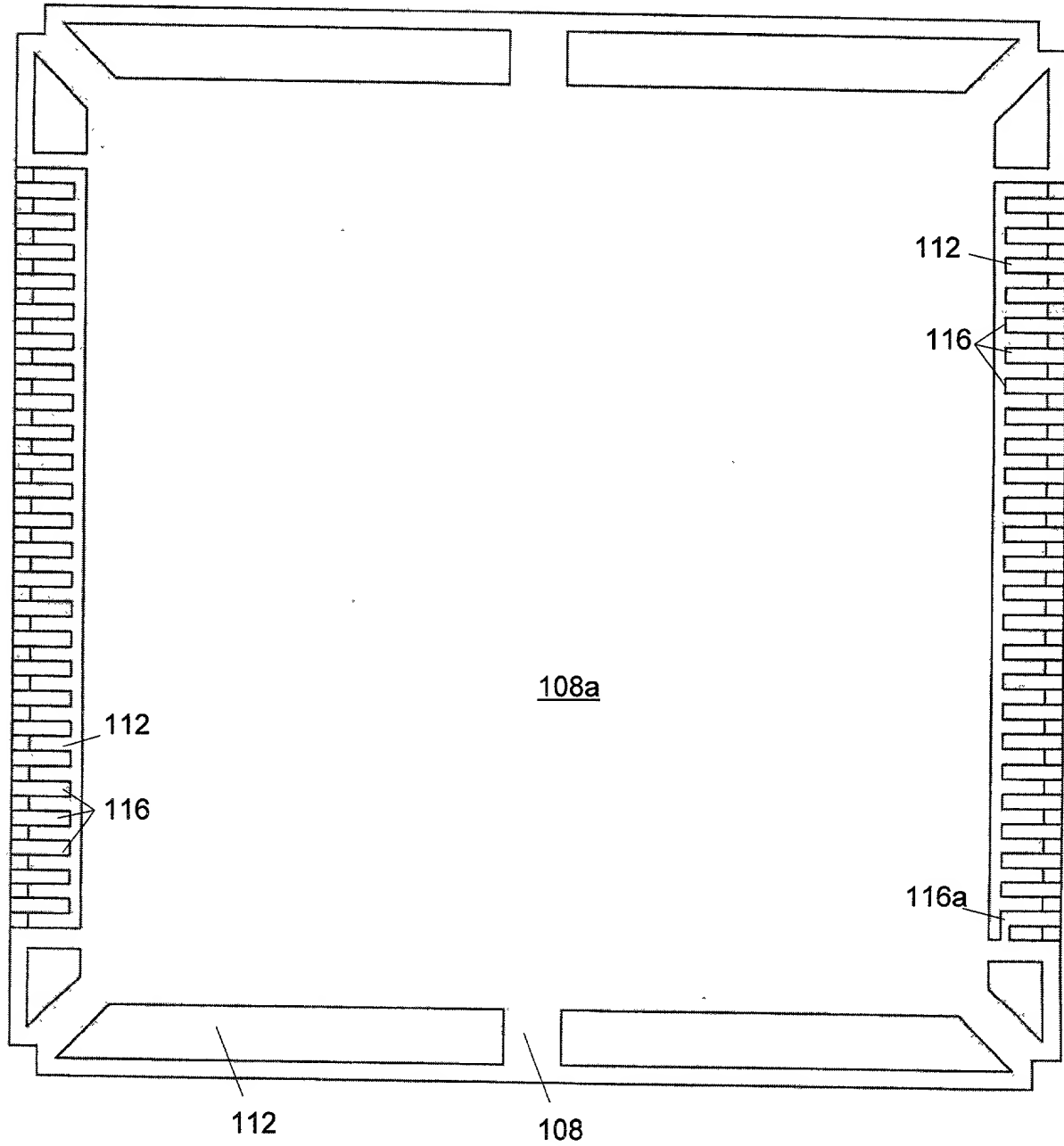
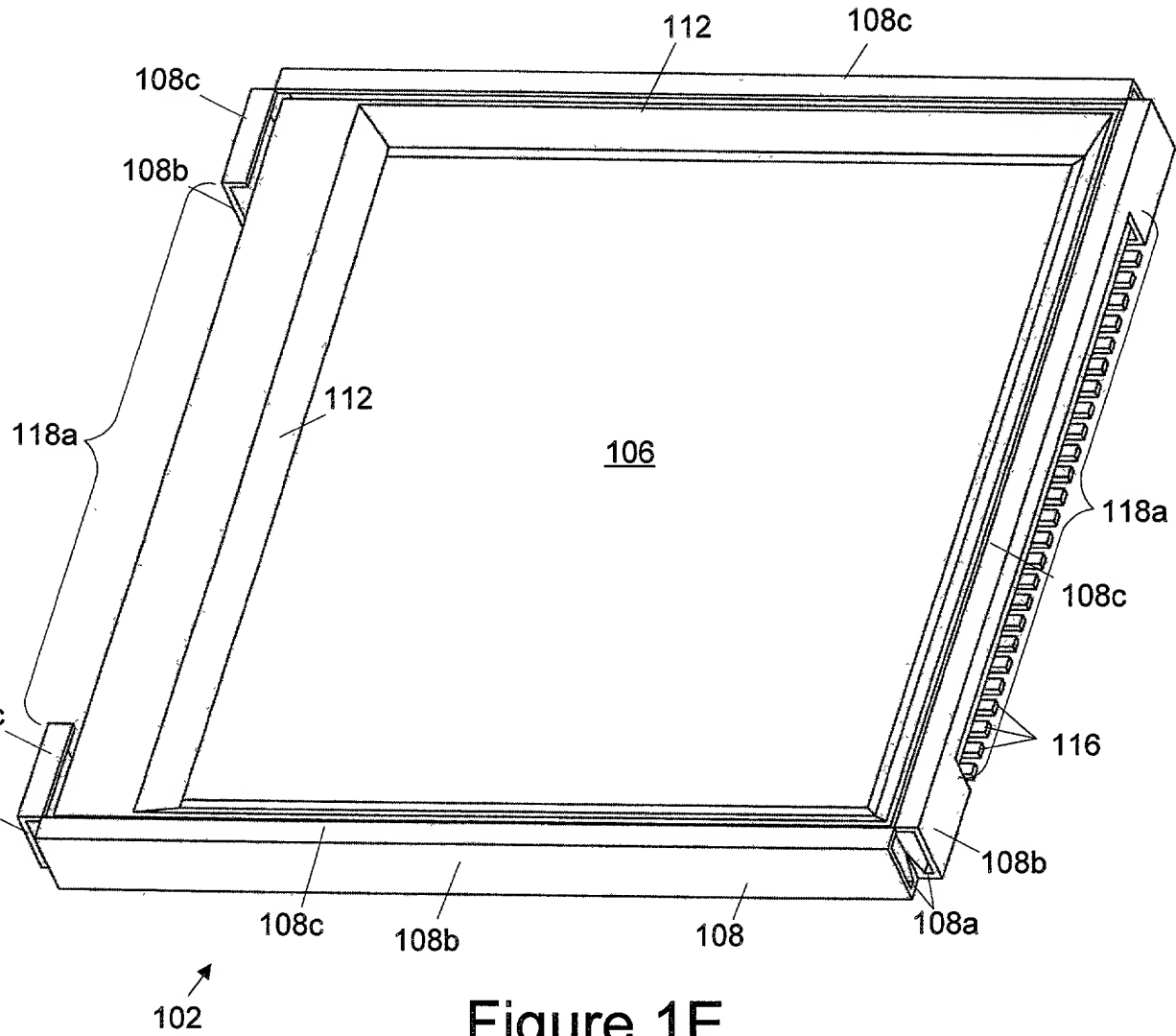


Figure 1D

004050-424350



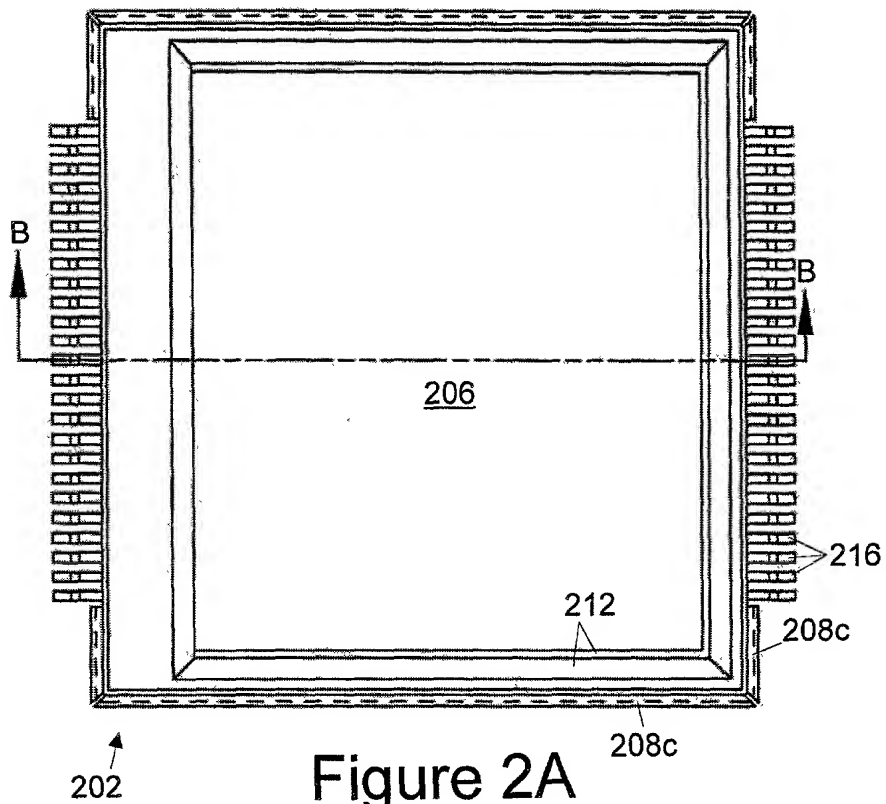


Figure 2A

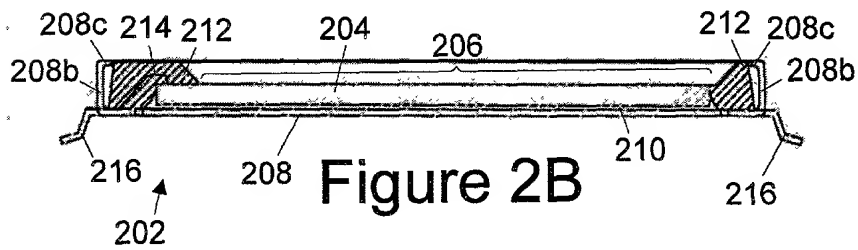


Figure 2B

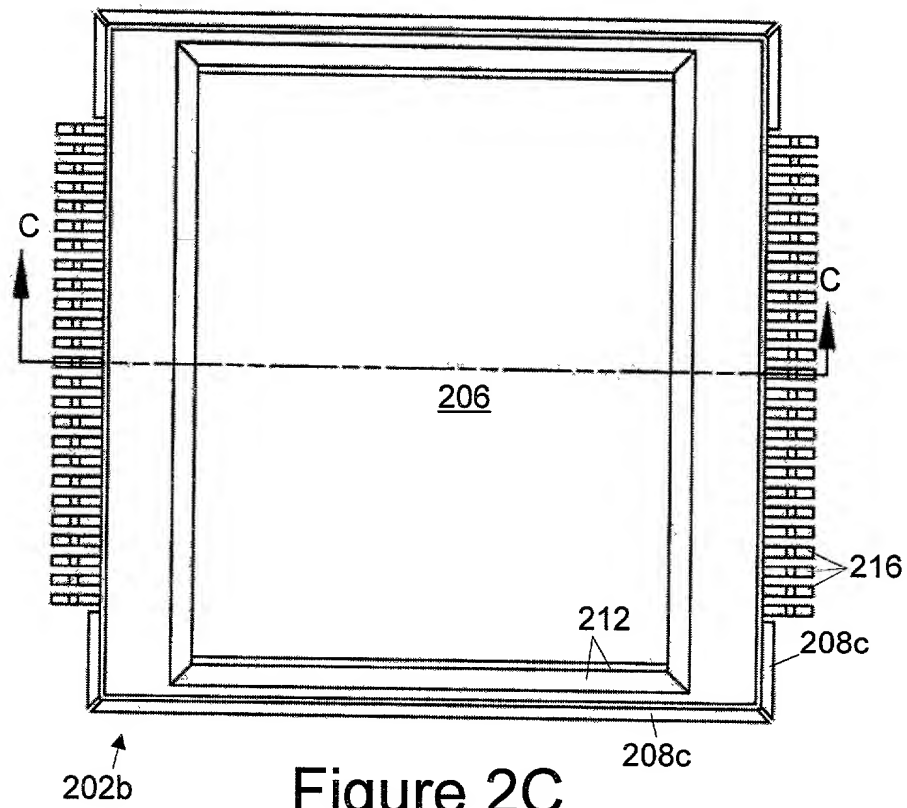


Figure 2C

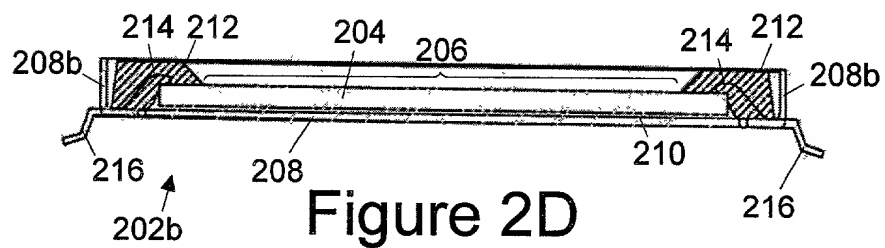


Figure 2D

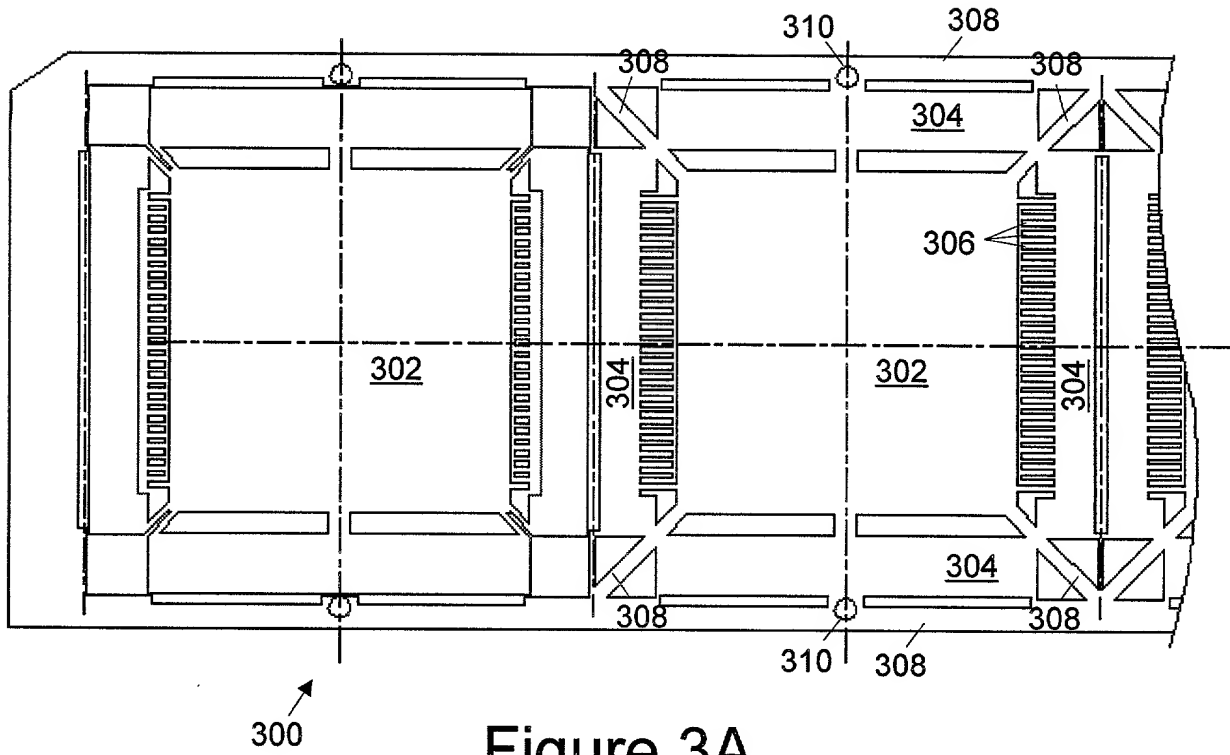


Figure 3A

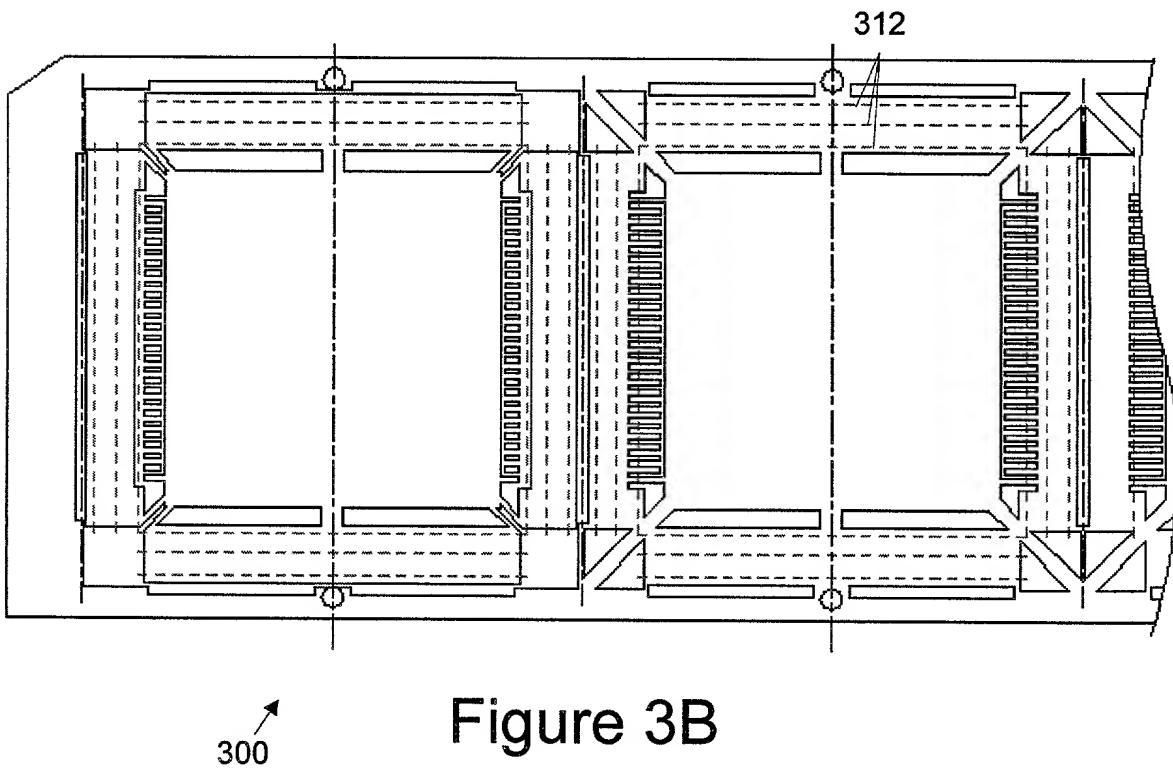


Figure 3B

004050-18695960

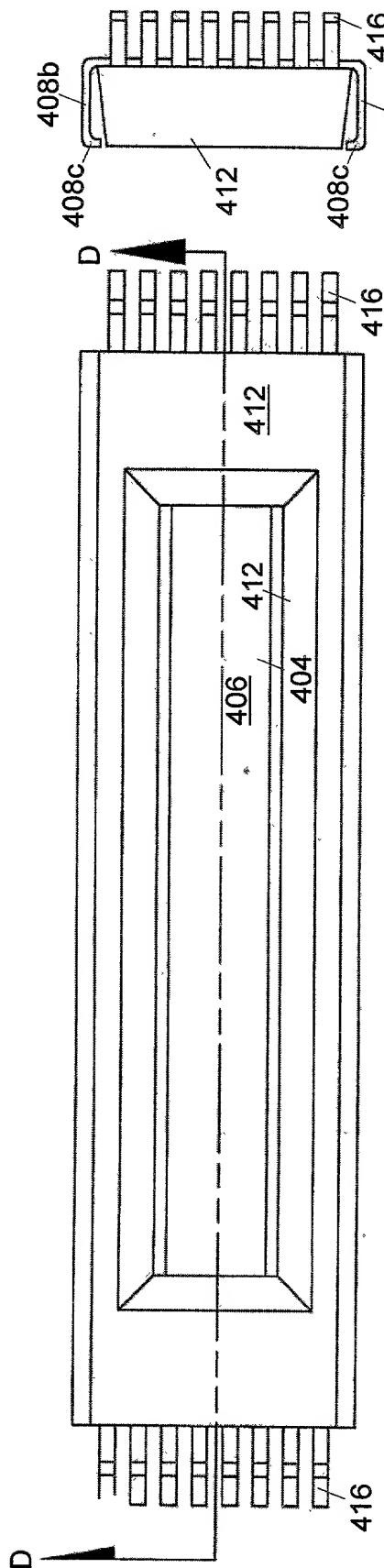


Figure 4A

Figure 4B

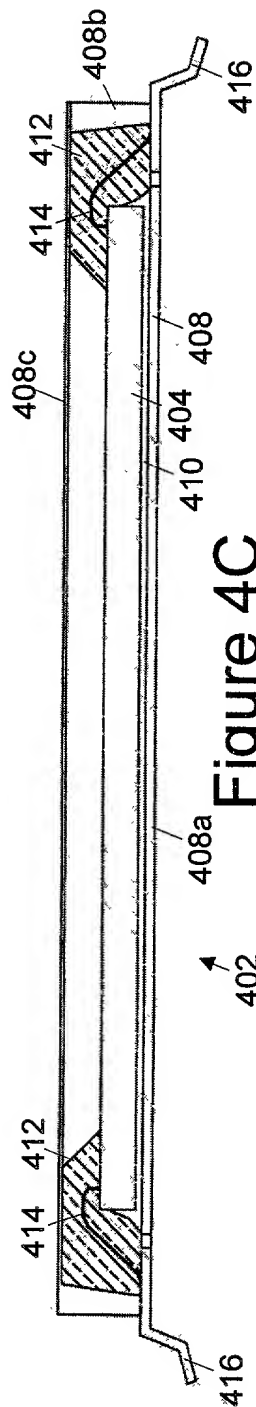


Figure 4C

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name,

I believe I am the original, first, and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled

SURFACE MOUNT PACKAGE WITH INTEGRAL ELECTRO-STATIC CHARGE  
DISSIPATING RING USING LEAD FRAME AS ESD DEVICE

the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s): Priority Claimed

_____ (Number)	_____ (Country)	_____ (Day/Month/Year)	____ Yes ____ No
-------------------	--------------------	---------------------------	------------------

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information material to the patentability of this application as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

_____ (Application Serial #)	_____ (Filing Date)	_____ (Status)
---------------------------------	------------------------	-------------------

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint Theodore E. Galanthay, Reg. No. 24,122; Lisa K. Jorgenson, Reg. No. 34,845; Robert D. McCutcheon, Reg. No. 38,717; Mario Donato, Reg. No. 37,817; James E. Bradley, Reg. No. 27,536; Charles D. Gunter, Jr., Reg. No. 29,386; Andrew J. Dillon, Reg. No. 29,634; Jack V. Musgrove, Reg. No. 31,986; Daniel E. Venglarik, Reg. No. 39,409; Brian F. Russell, Reg. No. 40,796; Matthew W. Baca, Reg. No. 42,277; and Antony P. Ng, Reg. No. 43,427 to prosecute this application and to transact all business in the U.S. Patent and Trademark Office in connection therewith.

Please send all correspondence to:

Lisa K. Jorgenson  
STMicroelectronics, Inc.  
1310 Electronics Dr.  
Carrollton, Texas 75006.

Inventor's Signature: Anthony M. Chiu  
Full Name of Inventor: Anthony M. Chiu  
Date of Signature: \_\_\_\_\_  
Residence Address: 2563 Buttercup Drive  
Richardson, Texas 75082  
Citizenship: U.S.A.  
Post Office Address: Same as above